May 2009
IYA Discovery Guide

This Month's Theme:

Our Sun

Featured Activity:

Modeling the Sun and Earth

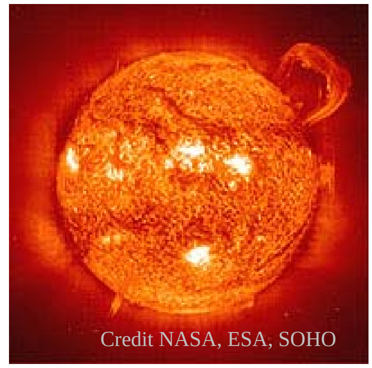
Featured Observing Object:

Sun

The International Year of Astronomy is a global celebration of astronomy and its contributions to society and culture, highlighted by the 400th anniversary of the first use of an astronomical telescope by Galileo Galilei.
Join us as we look up! http://astronomy2009.us

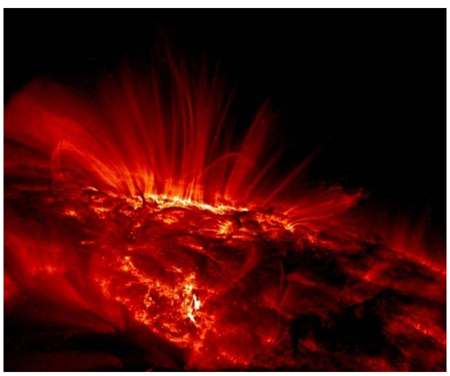
The Astronomical Society of the Pacific increases the understanding and appreciation of astronomy by engaging scientists, educators, enthusiasts and the public to advance science and science literacy.
http://www.astrosociety.org

May's Topic:
Our Sun


Credit NASA, ESA, SOHO

It warms the days, gives plants energy to grow, and allows us to see everything around us. In fact, without our Sun, we would not be here at all! Born from a cloud of gas and dust about 5 billion years ago, our Sun is a relatively quiet middle-aged star of average size in the suburbs of the Milky Way galaxy. But for Earthlings, the Sun couldn't be more special or fascinating.

As normal as our Sun seems on paper, it's not such a tame place. It was once thought that the Sun and all of the objects in the night sky were stable, unchanging spheres. When Galileo observed the sun through a telescope, his observations turned that idea on its head. He was one of the first people to record sunspots using a telescope. Sunspots are dark, irregular areas on the surface of the Sun caused by changing magnetic fields. They appear and disappear over hours to months and can be larger in size than the whole Earth.


Credit NASA, ESA

Even though it is far away, the Sun's influence is so powerful that eruptions can affect satellites and power grids here on Earth and cause the beautiful auroras. Scientists at NASA are busy learning about the Sun's activity using some hot new technology. The STEREO mission has sent two space probes into the Earth's orbit- one ahead and one behind. Just like our two eyes allow us to see in 3D, the two cameras give us a 3D picture of the Sun. The Hinode mission is showing a magnetic field even more active than previously thought. And the THEMIS mission is investigating how the solar wind powers auroras like the Northern Lights.

The activity attached here will help you better understand the distance and size difference between the Sun and Earth. Try it out and see if you can guess the right distance in this scale model.

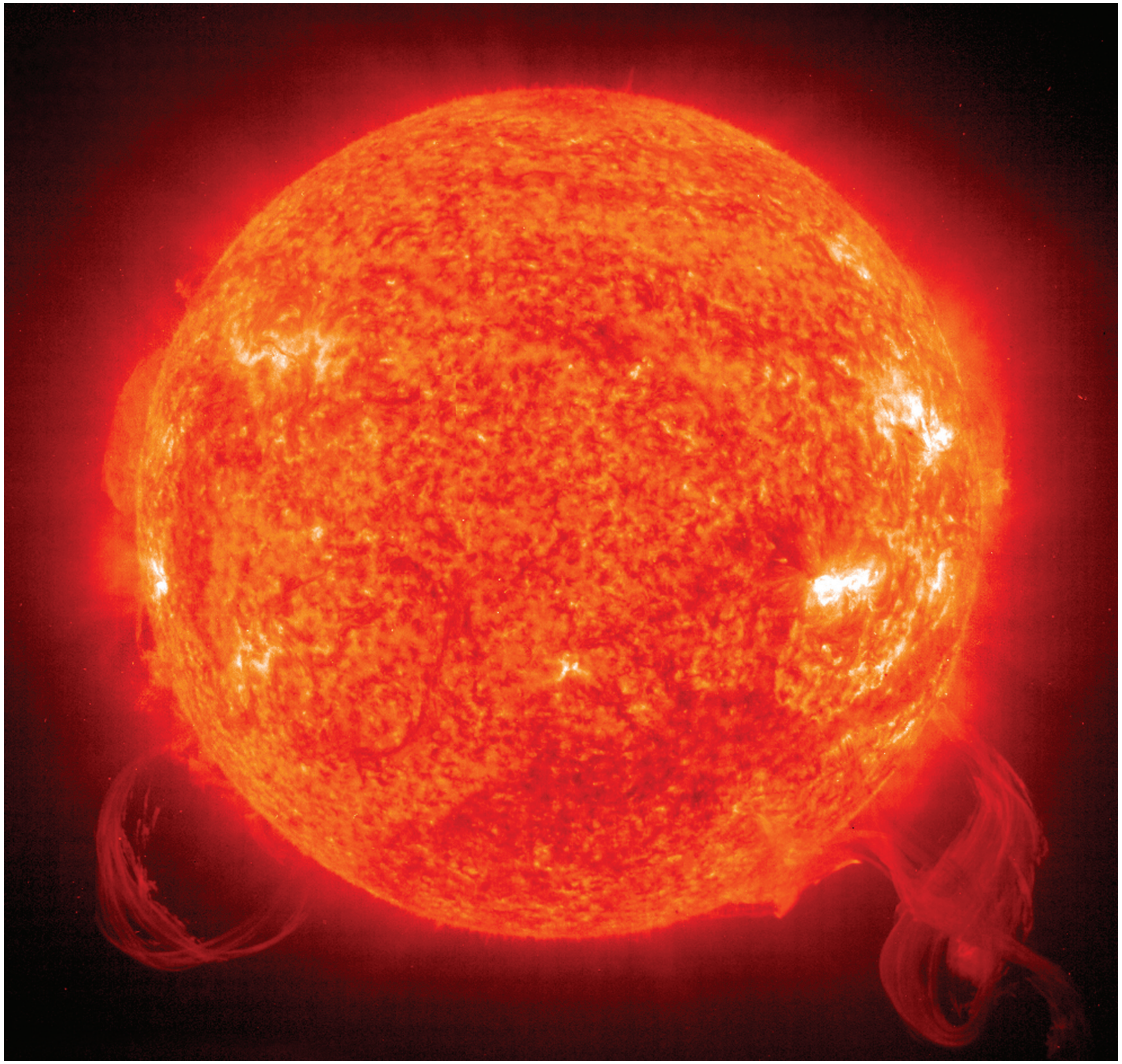
***It is very dangerous to observe the Sun directly. It can hurt your eyes and even cause blindness. Do not stare directly at the Sun or look at the Sun through a telescope without an approved solar filter. Find tips on safely observing the Sun here: http://www.spaceweather.com/sunspots/doityourself.html

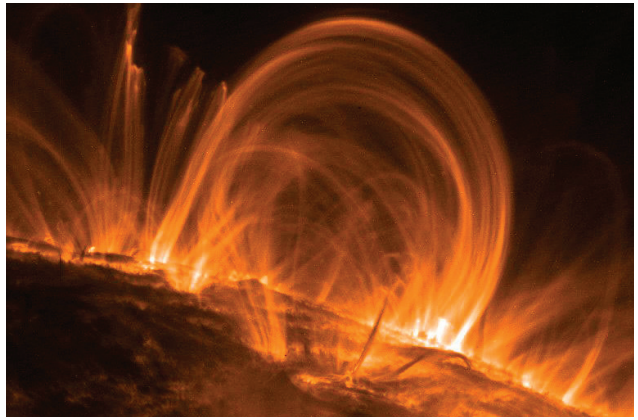
You can also find wonderful live pictures of the Sun here: http://www.spaceweather.com/

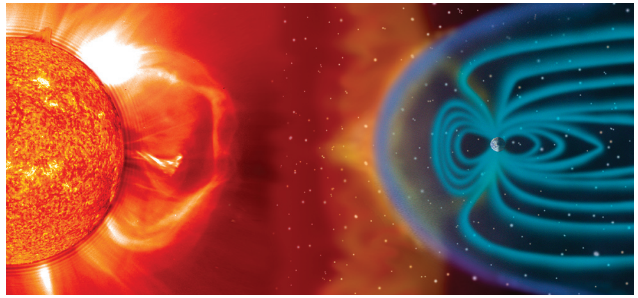
Learn more about the Sun from NASA.
Find more activities featured during IYA 2009.
See what else is planned for the International Year of Astronomy.

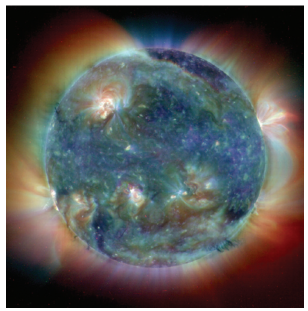
National Aeronautics and Space Administration
www.nasa.gov

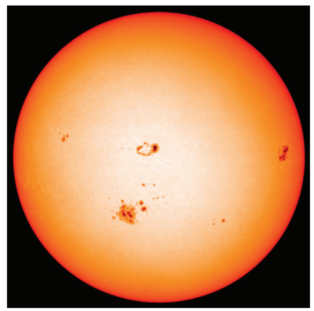
Our Star — The Sun

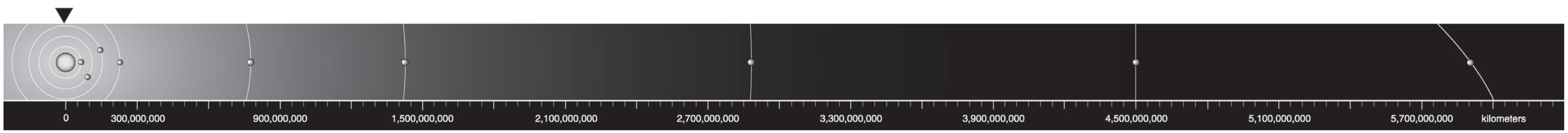












National Aeronautics and Space Administration
www.nasa.gov

Our Star — The Sun

Our solar system's star, the Sun, has inspired mythological stories in cultures around the world, including those of the ancient Egyptians, the Aztecs of México, Native American tribes of North America and Canada, the Chinese, and many others. A number of ancient cultures built stone structures or modified natural rock formations to observe the Sun and Moon — they charted the seasons, created calendars, and monitored solar and lunar eclipses. These architectural sites show evidence of deliberate alignments to astronomical phenomena: sunrises, moonrises, moonsets, even stars or planets.

The Sun is the closest star to Earth, at a mean distance from our planet of 149.60 million kilometers (92.96 million miles). This distance is known as an astronomical unit (abbreviated AU), and sets the scale for measuring distances all across the solar system. The Sun, a huge sphere of mostly ionized gas, supports life on Earth. It powers photosynthesis in green plants, and is ultimately the source of all food and fossil fuel. The connection and interactions between the Sun and Earth drive the seasons, ocean currents, weather, and climate.

The Sun is 332,900 times more massive than Earth and contains 99.86 percent of the mass of the entire solar system. It is held together by gravitational attraction, producing immense pressure and temperature at its core. The Sun has six regions — the core, the radiative zone, and the convective zone in the interior; the visible surface, known as the photosphere; the chromosphere; and the outermost region, the corona.

At the core, the temperature is about 15 million degrees Celsius (about 27 million degrees Fahrenheit), which is sufficient to sustain thermonuclear fusion. The energy produced in the core powers the Sun and produces essentially all the heat and light we receive on Earth. Energy from the core bounces around the radiative zone, taking about 170,000 years to get to the convective zone. The temperature drops below 2 million degrees Celsius (3.5 million degrees Fahrenheit) in the convective zone, where large bubbles of hot plasma (a soup of ionized atoms) move upwards.

The Sun's "surface" — the photosphere — is a 500-kilometer-thick (300-mile-thick) region, from which most of the Sun's radiation escapes outward and is detected as the sunlight we observe here on Earth about eight minutes after it leaves the Sun. Sunspots in the photosphere are areas with strong magnetic fields that are cooler, and thus darker, than the surrounding region.

The temperature of the photosphere is about 5,500 degrees Celsius (10,000 degrees Fahrenheit). Above the photosphere lie the tenuous chromosphere and the corona. Visible light from these top regions is usually too weak to be seen against the brighter photosphere, but during total solar eclipses, when the Moon covers the photosphere, the chromosphere can be seen as a red rim around the Sun and the corona forms a beautiful white halo.

Above the photosphere, the temperature increases with altitude, reaching temperatures as high as 2 million degrees Celsius (3.5 million degrees Fahrenheit). The source of coronal heating has been a scientific mystery for more than 50 years. Likely solutions have emerged from observations by the Solar and Heliospheric Observatory (SOHO) and the Transition Region and Coronal Explorer (TRACE) missions, which found patches of magnetic field covering the entire solar surface. Scientists now think that this magnetic "carpet" is probably a source of the corona's intense heat. The corona cools rapidly, losing heat as radiation and in the form of the solar wind — a stream of charged particles that flows to the edge of the solar system.

FAST FACTS

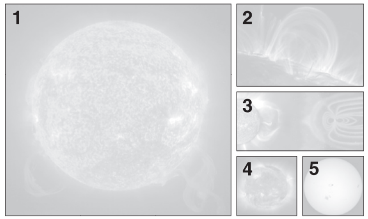
Spectral Type of Star	G2V
Age	4.6 billion years
Mean Distance to Earth	149.60 million km (92.96 million mi) (1 astronomical unit)
Rotation Period at Equator	26.8 days
Rotation Period at Poles	36 days
Equatorial Radius	695,500 km (432,200 mi)
Mass	1.989×10^{30} kg
Density	1.409 g/cm^3
Composition	92.1% hydrogen, 7.8% helium
Surface Temperature (Photosphere)	5,500 deg C (10,000 deg F)
Luminosity*	3.83×10^{33} ergs/sec

*Luminosity measures the total energy radiated by the Sun (or any star) per second at all wavelengths.

SIGNIFICANT DATES

150 AD — Greek scholar Claudius Ptolemy launches a millennium of misconception when he writes that the Sun and planets revolve around Earth.
1543 — Nicolaus Copernicus publishes *On the Revolutions of the Celestial Spheres* describing his heliocentric (Sun-centered) model of the solar system, beginning a new age of astronomy.
1645–1715 — Sunspot activity declines to almost zero, possibly causing a "Little Ice Age" on Earth.
1860 — Eclipse observers see a massive burst of material from the Sun; it is the first recorded coronal mass ejection.
1994 — The Ulysses spacecraft makes history as it makes the first observations of the Sun's polar regions, which cannot be studied from Earth.

ABOUT THE IMAGES



1 Two huge clouds of plasma erupt from the chromosphere of the Sun (SOHO image).

2 Magnetic fields are believed to cause huge, superhot coronal loops to tower above sunspots visible in the photosphere and chromosphere (TRACE image).

3 This illustration shows a coronal mass ejection from the chromosphere and interaction with Earth's magnetic field (not to scale).

4 A composite image of the Sun's corona taken in three wavelengths emitted at different temperatures shows a very active star (SOHO image).

5 These large sunspots in the photosphere were associated with several powerful solar flares in 2003 (SOHO image).

FOR MORE INFORMATION

solarsystem.nasa.gov/planets/profile.cfm?Object=Sun

LG-2005-12-564-HQ — JPL 400-1253C 12/05

May 2009 Featured Observing Object:

Sun

Finder Chart

For information about the Sun: http://svs.gsfc.nasa.gov/Gallery/NASAsSun-EarthGallery.html

To view: The Sun is very easy to find on any clear day.

WARNING: Do not ever look directly at the Sun unless you are using the proper filters.

For suggestions on the many ways to safely observe the Sun, refer to the Stanford Solar Center at: http://solar-center.stanford.edu/observe/

With the proper solar filter in place, observe the Sun through a telescope. You might see what Galileo saw when he turned his telescope toward the Sun – dark smudges on the face of the Sun. The "smudges" are called sunspots and they mark places where the Sun's strong magnetic field is breaking through the surface.

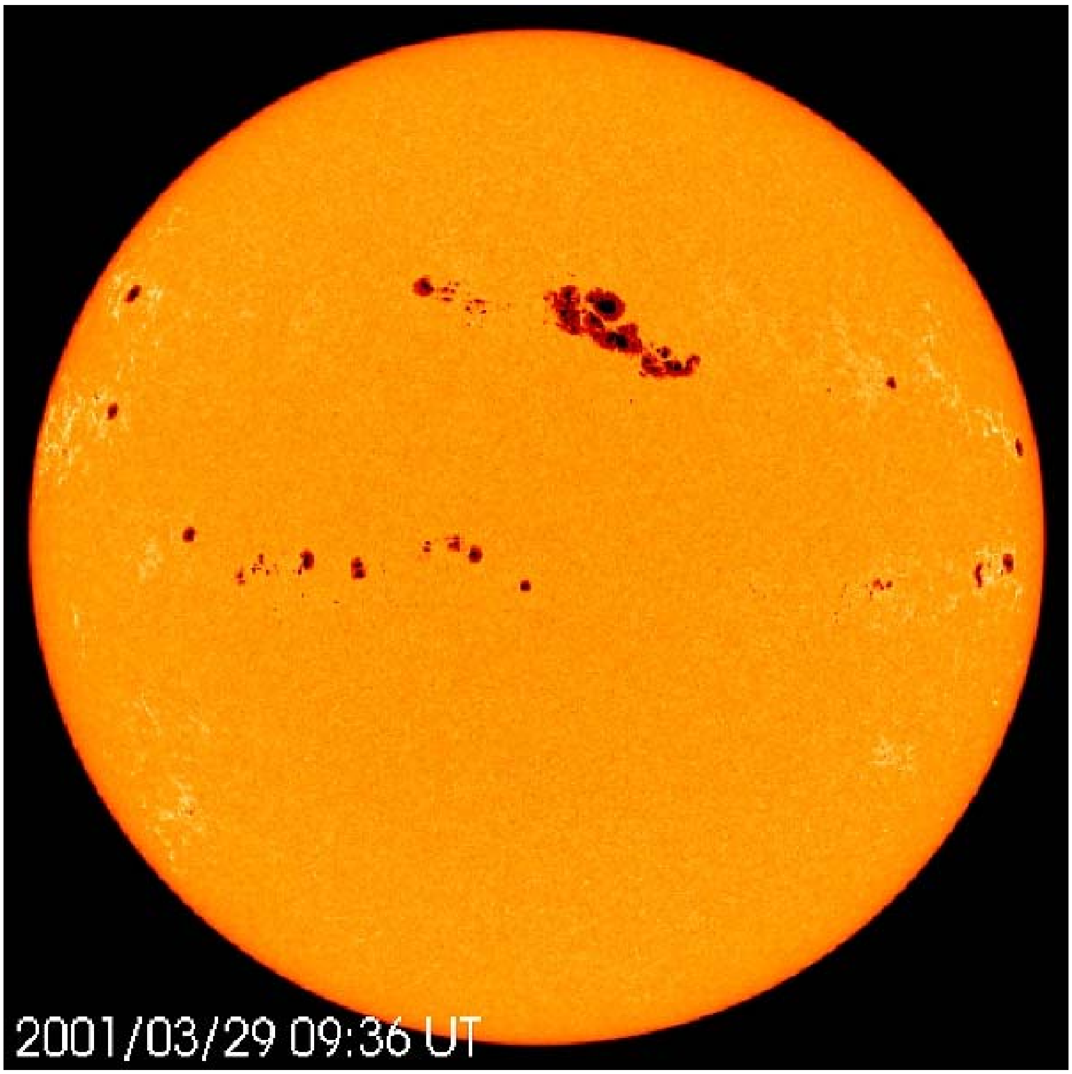
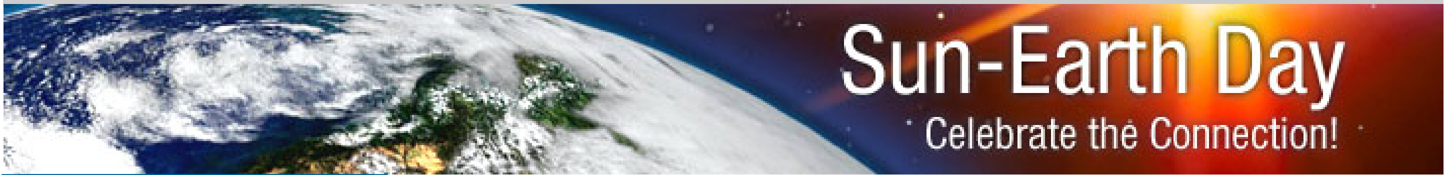


Image credit: SOHO (ESA & NASA)



Public Outreach
- Make and Take Activities

What You'll Need

- copies of the Sun and Earth handout sheet (see next page)
- measuring tape
- a large room or a long hallway where you will be able to walk 65 feet in a straight line without many obstacles
- (optional) scissors
- (optional) 65 feet length of string

Note: Copies of our readymade cardstock version of this Sun-Earth scale model are available for free by request. If you need copies for a specific event or education program, email us at outreach@cse.ssl.berkeley.edu

Both English and Spanish versions available.

Scale Model of Sun and Earth

About this Activity

This activity explores the relative size of Sun and Earth as well as the distance between them.

Below right: Looking toward the model Sun from the model Earth. A pre-measured piece of string was used to mark the appropriate distance for the scale model.

Preparation

Measure 65 feet (the distance between Sun and Earth in the scale of our model) from where you will be doing this activity and mark the distance for later reference. If you do not have a fixed location, we find it helpful to have a piece of string cut to exactly 65 feet in length for you to use as a reference during the activity.

If you want your participants to guess the size of the Earth, you might want to keep the image of Earth out of sight by cutting off the top of the hand-out page along the dash line.

To Do and Notice

1) Show participants the image of the Sun. (This is a good opportunity to notice what the Sun's surface look like and to point out that the Sun is not as featureless and uniformly bright as it might look to our eyes.) Ask participants to guess how big the Earth would be if the Sun is the size of this image.

2) Reveal the answer by showing the image of Earth. (Optional: you might want to let the participants cut out the Earth and the disc of the Sun instead of using the 2 sections of the handout sheet.) Ask participants to guess how far the model Earth should be from the model Sun. We suggest allowing participants to walk to where they think the distance should be. We find it helpful to tape the model Sun to a spot around eye-level at the starting point and have the facilitator walk with the participants. The model Earth should be 65 feet away from the model Sun. Use the marker you placed earlier (or the cut piece of string) to guide you.

3) (Optional) At 65 feet away, look back towards the model Sun. Notice how big it looks to you at this distance. At this scale, the model Sun should be about the same size as the actual Sun would appear to us here on Earth. (It is always a good idea to remind participants not to look directly at the Sun.) Since this part requires a basic understanding of ratio and scale model, it might not be appropriate for all participants.

Activity Notes

"Why does the Sun I see in the sky look different from this picture?" is a common question. The Sun image here was taken by a telescope that is mounted on a satellite in space (the TRACE mission to be exact). Besides being able to see farther than we can and without the clouds and Earth's atmosphere in the way, this telescope also looks at a different kind of light. The Sun gives off different kinds of energy, only part of that is in the form of visible light which we can see. The telescope that took this picture looks at the extreme ultraviolet (EUV) light coming from the Sun.

Related Websites

TRACE Education Resources: the Sun, its structure, and the satellite mission.
http://trace.lmsal.com/Public/eduprodu.htm

Stanford Solar Center: About the Sun
http://solar-center.stanford.edu/about/

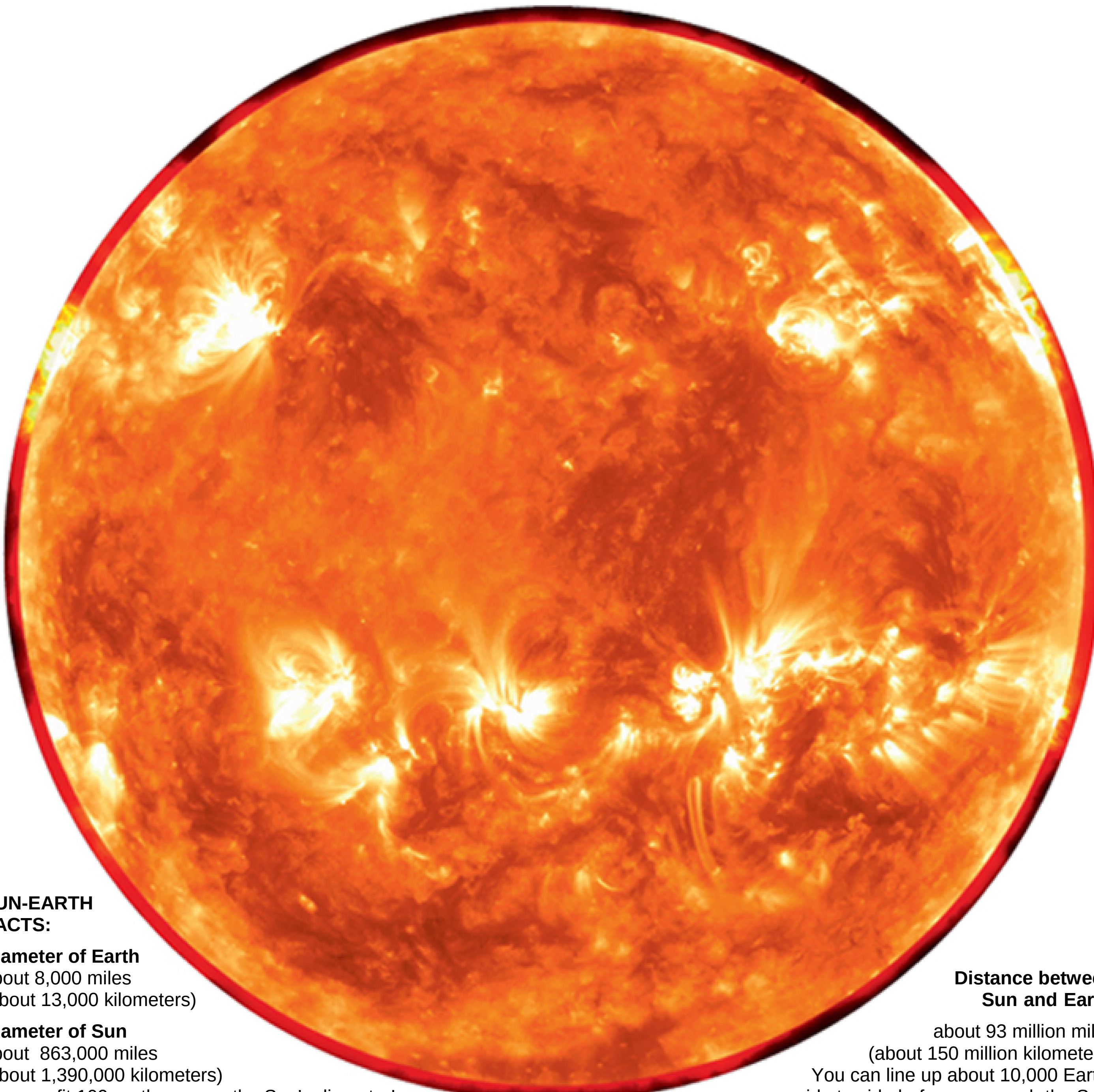
NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION

http://sunearthday.nasa.gov

1. Cut out the images of the Sun and the Earth.
2. To demonstrate the distance between Sun and Earth at this scale, separate the images 65 feet (about 20 meters) apart. This distance represents approximately 93 million miles (150 million kilometers).

This image of Earth is scaled to the proper size in relation to the image of the Sun below.

Earth 



SUN-EARTH FACTS:

Diameter of Earth
about 8,000 miles
(about 13,000 kilometers)

Diameter of Sun
about 863,000 miles
(about 1,390,000 kilometers)
You can fit 109 earths across the Sun's diameter!

Distance between Sun and Earth:
about 93 million miles
(about 150 million kilometers)
You can line up about 10,000 Earths side to side before you reach the Sun.

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The Night Sky Network is a nationwide coalition of amateur astronomy clubs bringing the science, technology, and inspiration of NASA's missions to the general public.

We share our time and telescopes to provide you with unique astronomy experiences at science museums, observatories, classrooms, and under the real night sky.
http://nightsky.jpl.nasa.gov

The International Year of Astronomy (http://astronomy2009.us) aims to help citizens of the world rediscover their place in the Universe through the daytime and nighttime sky. Learn more about NASA's contributions to the International Year of Astronomy at http://astronomy2009.nasa.gov